TEST PLAN
K1 WATER DISINFECTION GENERATOR

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10/10/19

Revision History:

Version	Revision Date	Description	Author
Diego	10/27/2019	Update from old documents	2

Contents

1 Introduction

The goal of the K1 Chlorine Generator is to produce sodium-hypochlorite cheaply using common salt, water, and electricity to purify water for consumption use. A previous control system has been implemented using the BeagleBone Black microcontroller board. This system will need to be upgraded with the following requirements and will be written in C code. It will need to control a batch chlorine generation process. It will determine that the correct electrolytic solution has been produced and will adjust if necessary. It will monitor power consumption of the electrolytic cell to determine when the correct amount of oxidant has been made. It will continue the batch process until the oxidant tank level is full and start the process when the oxidant tank is empty. It will need error handling procedures if something should go wrong, for instance if there is no water in the container. In this event an error code will need to be displayed on the LCD screen and a message sent out using ethernet to a server.

2 Relationship to other documents

- Functional Specification;
- Preliminary Requirements Document;
- Operation of Controls System K1.
- Test Plan Project 9 doc REH Comments 033016

3 System overview

The essential systems to the K1 Chlorine Generation consists of a brine generator, an oxidant tank, and electrolyte tank, and an electrolytic cell used to create the sodium-hypochlorite from an electrolyte solution made from a fully saturated brine solution and water. When a voltage is applied to the electrolytic cell it starts an electrolysis process. Other components include a hermetically sealed electrolytic cell power supply able to handle high current draw, a solid state relay to control when the voltage gets applies to electrolytic cell, a mechanical float valve to control that amount of water that goes into the brine tank, solenoid valves controlled by the microcontroller used to regulate the flow of water, brine, electrolyte and oxidant fluids, level switch indicator titanium rods, rotationally molded tanks with spin fittings for level switches and the BeagleBone Black microcontroller board to automated the batch process. The goal of the team is to upgrade the system software. The team will program the BeagleBone Black to interface with the hardware components using C to control the batch process so it can be automated.

4 Features to be tested/not to be tested

4.1 Features to be tested

The following are features of the controls system software to be tested. There are I/O signals from the BeagleBone Black that will demonstrate whether the software is programmed correctly and operate as expected:

4.1.1 State 1 of Batch Process

Inputs to BeagleBone

- Internal Run/Standby Switch signal.

Outputs from BeagleBone Black

- System Power signal;
- Internal indicator Light Yellow signal.

4.1.2 State 2 of the Batch Process

Inputs to BeagleBone Black

- Oxidant Tank Level Switch Referecne LSR001 signal;
- Oxidant Tank Level Switch Low LSL001 signal

Outputs from BeagleBone Black

- Internal Indicator Light Green signal.

4.1.3 State 3 of Batch Process

Inputs to Beagle Bone

- **Electrolyte Tank Level Switch Reference LSR002 signal;**
- **Electroylte Tank Level Switch Low LSL002 signal.**

Outputs from BeagleBone Black

- **Open Brine Solenvoid Valve E0V003 signal;**
- **Close Brine Solenvoid Valve E0v003 signal.**

4.1.4 State 4 of Batch Process

Inputs to BeagleBone Black

- Electrolyte Tank Level Switch Reference LSR002 signal;
- Electrolyte Tank Level Switch High LSH002 signal.

Outputs from BeagleBone Black

- Open Water Solenoid Valve EOV001 signal;
- Close Water Solenoid Valve EOV001 signal.

4.1.5 State 5 of Batch Process

Inputs to BeagleBone Black

- Cell Power Supply Status signal;
- Electrolytic Cell Amperage analog signal;

- Electrolytic Cell Voltage analog signal.

Outputs from BeagleBone Black
- Cell Power Enable signal;
- Power H2 Vent Fan signal;
- Open Water Solenoid Valve EOV001 signal;
- Open Brine Solenoid Valve EOV003 signal;
- Close Water Solenoid Valve EOV001 signal;
- Close Brine Solenoid Valve EOV003 signal.

4.1.6 State 6 of Batch Process
Input to BeagleBone Black
- Cell Power Supply Status signal.

Outputs from BeagleBone Black
- Open Electrolyte Tank Drain Solenoid Valve EOV002 signal;
- Close Electrolyte Tank Drain Solenoid Valve EOV002 signal.

4.1.7 State 7 of Batch Process
Inputs to BeagleBone Black
- Oxidant Tank Level Switch High LSH001 signal;
- Oxidant Tank Level Switch Low LSL001 signal;
- Oxidant Tank Level Switch Reference LSR001 signal.

Outputs from BeagleBone Black
- Internal Indicator Light Yellow signal.

4.1.8 Alarm/ Troubleshooting
Simulation of hardware failure will be implemented to test Alarm output signals.

Inputs to BeagleBone Black
- Electrolyte Tank Level Switch High High LSHH002 signal;
- Oxidant Tank Level Switch High High LSHH001 signal;
- Oxidant Tank Level Switch Low Low LSLL001 signal;
- Electrolyte Tank Level Switch Reference LSL001 signal;
- Oxidant Tank Level Switch Reference LSR001 signal.

Outputs from BeagleBone Black
- Internal Indicator Light Red signal;
- Alarm #1 signal;
- Alarm #2 signal;

- Alarm #3 signal;
- Alarm #4 signal;
- Alarm #5 signal;
- Alarm #6 signal;

Alarm #7 signal.

4.1.9 Sending of errors via Ethernet using TCP

Sending of a specified message via Ethernet using TCP to a designated server.

4.2 Features not to be tested

All features programmed into the software will be tested. The following is a list of the features that will not be tested:

4.2.1 Hardware Components

No hardware components will be tested. Simulation of hardware will be implemented with a development board and electronic parts. The team is only responsible for the development of the control system software.

5. Pass/Fail criteria

If output signal is driving at XX voltage and light emitting diode is illuminated, then this constitutes **Success/Pass;**

If output signal is not driving at XX voltage or light emitting diode is not illuminated, then this constitutes a **Failure;**

We will program a specified port to send an output signal to test input signals. If simulated input parameters are correct and an output signal from the specified port is observed, then this constitutes **Success/Pass;**

If simulated input parameters are correct and no output signal from the specified port is present, then this constitutes a **Failure.**

If approved server receives an error message from K1 displaying [error][XXX] then this constitutes **Success**.

6. Approach

With the development board and electronic components, functions of the hardware will be simulated. The output signals will be tested by placing a light emitting diode in series with the specified port to indicate if output signal is being generated. The voltage will be measured on the port, in order to make sure the BeagleBone is driving the signal. The input signals will be simulated with voltage supply and use of a current sensor; this will test the analog inputs. By simulating all the input parameters, the team will be able to step through the source code which will give us a clear indication if the software is operating how it should be. Testing error messages will be done by displaying an LCD screen and a prototype server in which will receive error messages where the IP address is dynamic. All test equipment will be provided by Aqua Access and testing will be done on site.

7. Testing materials (hardware/software requirements)

- BeagleBone Black;
- Development board/Breadboard;
- Electronics (Resistors, Capacitors, Transistors, LED's, etc.);
- Jumper Wires;
- Current Sensor;
- Voltage Supply;
- Digital Multimeter;
- Prototype electrolytic cell.
- Ethernet port (Make and Model to be decided)
- Ethernet cable
- Testing PC which will act as a server

8. Test Cases

8.1 Test Case #1: <Brief Description and/or Name>

Tested By:	
Test Type	
Test Case Number	1
Test Case Name	
Test Case Description	**Section**

Item(s) to be tested	
1	
2	
3	
4	

Specifications	
Input	**Expected Output/Result**
1.	1.

Procedural Steps	
1	
2	
3	

8.2 Test Case #2: <Brief Description and/or Name>

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<tr><td colspan="2">Input</td><td>Expected Output/Result</td></tr>
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9. Testing Schedule

Test Dates	Description	Responsible Engineers
	Test Case 1	
	Test Case 2	